EFFECT OF PRUNING ON GROWTH CHARACTERISTICS OF *Melia composita*

BY

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(J-17-M-495)

Thesis submitted to Faculty of Postgraduate Studies

In partial fulfillment of the requirements

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IN

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2019

M.Sc.

EFFECT OF PRUNING ON GROWTH CHARACTERISTICS OF
Melia composita

Qurat Ul Ain Binte Syed

2019

CERTIFICATE – I

This is to certify that the thesis entitled **"EFFECT OF PRUNING ON GROWTH CHARACTERISTICS OF *Melia composita*"** submitted in partial fulfillment of the requirements for the degree of **Master of Science in Forestry** to the Faculty of Post Graduate Studies, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu is a record of bonafide research, carried out by **Ms. Qurat Ul Ain Binte Syed**, Registration Number **J-17-M-495** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma. It is further certified that help and assistance received during the course of investigation have been duly acknowledged.

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ABSTRACT

Title of Thesis	:	"EFFECT OF PRUNING ON GROWTH CHARACTERISTICS OF *Melia composita*"
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ABSTRACT

The present investigation "Effect of pruning on growth characteristics of *Melia composita*" was conducted at experimental farm of division of Agroforestry, Sher –e – Kashmir University of Agricultural Sciences and Technology of Jammu during the year 2018 - 2019. The experiment involved four treatments wherein 2.5-year-old block plantations of *Melia composita* were subjected to initial pruning and subsequent topping off. The treatments included T_1 (unpruned trees as control), T_2 (initial pruning of lower crown), T_3 (topping off T_1) and T_4 (topping off T_2). The aim of the experiment was to assess the effect of early pruning on growth characteristics of *Melia composita* trees. Various growth parameters like tree height, crown spread, number of branches, diameter at breast height (dbh) and above ground biomass were studied. Efforts were also made to study the effect of various treatments on light transmission ratio LTR (%). Result showed that the growth parameters like height, crown spread, above ground biomass and light transmission ratio were significantly influenced by early pruning. Reduction in most of the growth parameters like height dbh, crown spread, and above ground biomass were evident in all pruning treatments, compared to control. Parameters like chlorophyll content, and leaf area were not affected by the early pruning treatments. The findings of the present investigation indicated that pruned trees showed a minor decline in few of the growth characteristics. However, this reduction is temporary or permanent, needs to be explored further. Thus, the current findings provide a scope for new management options in *Melia composita*.

Key words: *Melia composita*, early pruning, Topping off, Growth characteristics

Sandeep Sehgal
Signature of Major advisor

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Signature of Student

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ILLUSTRATIONS

LIST OF PLATES

Plate No.	Particulars	After page No.
1- 4	Photographs of field trial	22

LIST OF SYMBOLS AND ABBREVATIONS

%	Per cent
m	Metre
MT	Million tonnes
cm	Centimetre
mg	Megagram
ha	Hectare
kg	Kilogram
DBH	Diameter at breast height
mg	Milligram
cm^2	Square centimeter
^0C	Degree Celsius
LAI	Leaf area Index
et al.	And others
g	Gram
sec	Second
PAR	Photosynthetically Active Radiation
m^3	Cubic meter
yr	Year
SE (m)	Standard Error of the mean
RBD	Randomized Block Design

viz.,	Namely
Fig.	Figure
No.	Number
Pp	Pages
Temp.	Temperature
CS	Crown spread
Sci.	Science
Agri.	Agriculture
Univ.	University

Chapter-1

Introduction

CHAPTER-1

INTRODUCTION

In a developing country like India, there is a great demand for fuel wood and timber which is met out from trees growing in the forests and on the farms besides, forests is very important in maintaining ecological balance, as they provide habitat for a large number of flora and fauna. Forests play an important role in climate change, mitigation and adaptation and can improve the nutrient balance of soil by reducing unproductive nutrient losses from erosion and leaching and by increasing nutrient inputs through nitrogen fixation and increases biological activities by providing biomass and suitable microclimate (Schroth and Sinclair, 2003). But today, the forests in India are facing enormous pressure because of growing population. Out of 23.39% forest and tree cover in India, over 40% of forests are degraded due to anthropogenic activities (FSI, 2017). The rapid decrease in forest cover and low sustained yield has lead to the shortage of timber and fuel wood. Rehabilitation of these lands is being done by afforestation, reforestation, enrichment planting and agroforestry. Similarly, modern forest based industries have suffered for want of sustainable supply of wood, resulting in import of timber, paper and pulp and wood products from other countries. Nowadays, preference is being given to planting of fast growing, short rotation trees in agroforestry and other afforestation programmes. *Melia composita* (Malabar neem, Drek, Gora neem or nimabaro) is one such promising agroforestry species (Chaturvedi *et al*., 2017). Agroforestry is sustainable land management that maintains or increases total yield by combining food crops (annuals) with tree crops (perennials) and/or livestock on the same unit of land, either alternatively or at the same time, using management practices that suit the social and cultural characteristics of the local people and the economic and ecological conditions of the area. Very recently, one such tree that seems to be highly suitable for agroforestry is *Melia composita* belonging to the family Meliaceae. It is commonly reported from India to tropical Africa, southern China and through Malaya to tropical Australia at low and medium altitudes. In India *Melia composita* occurs in tropical moist deciduous forests of Sikkim Himalayas, North Bengal and Upper Assam, the Khasi hills of Orissa, Deccan and the Western Ghats, at altitudes of 1,500-1800 meters (Brandis, 1906; Parthiban *et al*., 2009). *Melia composita* tree attains a height of 20-25 meters, and a cylindrical

bole upto 9 meter length and 1.5 m in girth (Saravanan *et al*., 2013). It has good calorific value; 5043-5176 cal **(**Tripathi and Poonia, 2015). The tree is a strong light demander and is capable of withstanding wide range of climatic conditions. The tree is leaf less during winters and the new leaves appear in February – March. The whitish green flowers appear from March to May and they are replaced by bunches of ovoid drupes which cling on the tree till the next flowering season. The fruits of *Melia composita* are bitter and considered an anthelmintic (Srivastava, 2005). The bio-active constituents identified from *Melia composita* are found to possess insect antifeedant, antitumor, antioxidant inflammatory, antibacterial and fungicidal properties (Murugesan and Senthikumar, 2012). Wood is moderately hard and can be used for packing cases, ceiling planks, building purposes, agricultural implements, pencils, match boxes, splints, musical instruments and tea boxes. *Melia composita* is identified as a potential alternate pulpwood species and have revealed that *Melia composita* has pulp recovery higher than that of eucalyptus and has good bleachability indicating its suitability as an alternate pulp wood species (Parthiban *et al*., 2009). *Melia composita* trees also aid the planet by preventing temperature rise and checking gas emission in to the atmosphere as the trees are naturally endowed to absorb maximum carbon dioxide (Pradeep, 2015). It is being cultivated in the arid and semi-arid as well as semi moist areas of the country. Due to its fast growth and multiple uses, it is emerging as a favourite tree for forestry plantations in the states of Punjab, Haryana and Uttar Pradesh (Luna and Kumar, 2006).

It is therefore important to understand tree growth characteristics. Tree growth can be defined as the increase in dimensions of an individual tree through time (Bowman *et al*., 2012). The most commonly measured dimensions are height and diameter, because these are convenient measures that are strongly correlated with wood volume and biomass. The patterns of growth over the life span of a tree vary according to which dimension is measured. While patterns of growth vary according to tree species and growing conditions, in general height increases rapidly when a tree is young, but tends to level off when a tree attains maturity and height increment may approach zero. Thus in present scenario the species is getting greater attraction by farmers, foresters and plantation growers.

Trees when included in agroforestry, need to be managed in order to obtain maximum productivity of the over story as well as understory crop and are able to

produce more fodder per unit area than agricultural crops. One such poplar canopy management technique is pruning, that involves the operation of "removal of live or dead branches or multiple leaders from standing trees for the improvement of the tree or its timber."Pruning of tree component is a powerful approach to regulate light, nutrients and other resource competition (Frank and Eduaro, 2003). Conceptually trees are considered to be a terrestrial carbon sink (Houghton *et al*., 1998). The estimation of CO_2 assimilation is the first step in the construction of the whole-plant or crop carbon balance. Tree growth data are crucial to understand the mechanism underlying changes in tree biomass, canopy structure and growth characteristics. Biomass production is directly co-related with pruning intensity and severely pruned tree tended to produce less biomass after pruning than lightly pruned trees (Zeng, 2003). Canopy light interception and absorption is fundamental for understanding many aspects of crop growth and productivity. Yield and market prices decrease considerably for trees without pruning interventions, since lumber must be almost knot-free in order to obtain a high monetary value. There have been fewer studies on the growth and development characteristics of *Melia composita* in sub-tropical conditions, especially when subjected to canopy management techniques like pruning lopping and pollarding. Therefore, the present investigation is proposed to be undertaken to study the effect of pruning on growth characteristics of *Melia composita* in the experimental farm of Division of Agroforestry located at Chatha, Jammu.

Objectives:

- To study the effect of pruning on growth characteristics of *Melia composita.*
- To study the light interception in *Melia composita.*

Chapter-2

Review of Literature

CHAPTER – 2

REVIEW OF LITERATURE

Melia composita Wiltd. a versatile fast growing, multipurpose tree and highly amenable for agroforestry with wide acceptability requires canopy management technique. Pruning is one of the operations to develop straight and clean bole. The amount of pruning affects the overall growth and survival of trees. Pruning objectives include risk reduction and the improvement of tree stability. On the other hand, pruning may also cause reduction in the rate of tree growth depending on pruning intensity. Therefore canopy management serves different purpose. The research work conducted so far in India and abroad and the available information relevant to the research investigation entitled **"EFFECT OF PRUNING ON GROWTH CHARACTERISTICS OF *Melia composita*"** have been reviewed in this chapter under the following headings:-

2.1 Growth and development of *Melia composita*

2.2 Effect of pruning and other tree canopy management on growth and biomass

2.3 Light transmission ratio (%)

2.1 Growth and development of *Melia composita*

Melia composita is a fast growing tree species growing at altitudes of 1500-1800 meters (Brandis, 1906; Parthiban *et al*., 2009). Due to its fast growth and multiple uses, it is emerging as a favorable tree for agroforestry in north Indian states (Luna and Kumar, 2006; Nuthan *et al*., 2009).

Sharma *et al*. (2017) conducted a study on *Melia composita* in the state of Punjab at Handesra, Mohali Village, Hoshiyarpur with the spacing 2×2, 3×3 and 4×4 in the year of 2014, 2015 and 2016. Both height and diameter were measured continuously for three consecutive years. The maximum increase in height and diameter was recorded in spacing of 3×3 m in 2016 and minimum was recorded in spacing of 4×4 in 2014 initial stage of year plant.

Parthiban *et al.* (2019) studied the growth pattern of *Melia dubia* in Tamil Naidu in 13 locations for a period of 4 years at three densities ranging between 2500/ha (2m×2m spacing) and 625 trees/ha (4 m×4 m spacing) and resulted that after 4 years the higher density recorded more height growth of 14.19 m at 2500 plants/ha followed by 13.25 m at 1100 plants/ha and 13.06 m in 625 plants/ha. Similarly the higher density registered average diameter at breast height 17.50 cm at 2500 plants/ha followed by 21.94 cm at 1100 plants/hand maximum of 25.75cm diameter at breast height was recorded plant density of 625 plants/ha. The higher density 2500 plants/ha registered average volume of 0.205 m^3 after four years of growth followed by 0.304 m^3/tree in medium density (1100 trees/ha) and 0.406 m^3/tree in the higher density of 625 plants/ha.

Saravanan *et al*. (2013) reported that *Melia dubia* cav. belonging to the family Meliaceae has its trade name as malabar neem. It is a large deciduous and fast growing tree with wide spreading branches on a stout, straight, tall bole and indigenous to the western ghats of southern India and is common in moist deciduous forests of Kerala (Gamble, 1992). Outside India, it is found in Sri Lanka, Malaysia, Java, China and Australia. *Melia dubia* with its multi-various uses like pulpwood, timber, fuel wood and plywood can fit as a suitable species for agro and farm forestry plantation programme.

Parthiban *et al.* (2019) reported that the wood of *Melia dubia* has been used as a timber particularly in the Thalavadi regions of Tamil Nadu to meet their domestic needs and highly amenable for plywood utility due to increased veneer recovery compared to the traditional plywood species like Eucalyptus.

Parthiban *et al.* (2019) reported that two pulp and paper industries in Tamil Nadu viz., Seshasayee paper boards limited and Tamil Nadu news print and papers limited have tested Melia wood for pulp and paper production and adopted this species for commercial plantation establishment.

Karatangi and Patil (2017) conducted the density experiment in All India Co-ordinated Research Project on Agroforestry, University of Agricultural Science, Dharwad to know the effect on growth and productivity of *Melia dubia*. The plantation under different densities (2500 trees/ha with spacing 4×1 m, 1666 trees/ha with spacing 4×1.5 m, 1250 trees/ha with spacing 4×2 m, 1000 trees/ha

with spacing 4×2.5 m, 833 trees/ha with spacing 4×3 m, 714 trees/ha with spacing 4×3.5 m and 625 trees/ha with spacing 4×4 m). The results showed that girth was significantly superior at planting density of 714 trees/ha (46.85, 50.14, 52.99 and 55.76 cm) and the lowest girth was recorded in density of 2500 trees/ha (27.50, 29.40, 30.92 and 32.82 cm). The study indicated height parameter showed similar trend of significant differences with maximum height was found in planting density of 714 trees/ha (10.59, 10.99, 11.22 and 11.43 m) and the minimum was in density of 2500 trees/ha (7.90, 8.22, 8.37 and 8.53 m) in all the observation periods.

Saravanan *et al*. (2013) studied wood characterization studies on *Melia dubia* cav. for pulp and paper industry at different age gradation at Forest College and Research Institute, Tamil Nadu, using five different age gradations viz., one, two, three, four and five year old *Melia dubia* wood samples. The result showed that basic density and bulk density of *Melia dubia* wood increases with age while moisture content decreased with increase in age of the tree and indicates that *Melia dubia* is good for pulp and paper industry due to superior pulp yield and quality. The productivity also indicated that *Melia dubia* is fast growing tree with the growth rate of 41.54 m3 ha^{-1} yr^{-1}.

Kulkarni (2007) conducted a suitability study on *Melia dubia* based agroforestry system in north Karnataka on one year plantation. Plant height, stem girth and canopy width were measured. The study resulted that *Melia dubia* did not have negative effect on growth and yield of crops grown in agroforestry and is suitable multipurpose crop to be grown in agroforestry system in North Karnataka.

Thakur (2014) conducted investigation at department of Forestry, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in well-established years old *Dalbergia sisso* plantation with 5 pruning intensities and turmeric under shisham shaded conditions and the result revealed that plant height and stem diameter was noted under 25% of pruning followed by 50% pruning, While the lowest plant height was recorded at 75% pruning but higher than open conditions.

Bhusara *et al.* (2018) studied growth and yield performance of green gram under two year *Melia composita* plantations with three spacing of S_1 (2 x 2m), S_2 (2x 3 m) and S_3 (2x 4 m) while S_0 as at College of Forestry, Navsari Agricultural

University, Navsari, Gujarat. Green gram crop (GV_1- Meha and GV_2- GM-4) were intercropped with *Melia composita* resulting less growth parameters and less yield as compared to open condition. The experiment resulted that treatment T_2-S0 GV2 recorded maximum plant height - 48.23cm, number of branches per plants - 3.62, number of leaves- 247.42 number of flower per plant -34.04, average number of pod per plant- 21.31, seed yield per plant- 4.94g and per hectare - 0.81 tonnes in open condition. Similarly in intercropping the growth and yield attributes of okra were minimum height -36.12 cm, number of branches per plants- 2.59, number of leaves- 110.57 number of flower per plant -19.13, average number of pod per plant- 15.08, seed yield per plant- 3.55g and per hectare- 0.58 tonnes were reported in T_4 (S1 GV2) i.e. in 2 x 2 closer spacing while under wider spacing of S_2 and S_3. Hence wider spacing of S_3 (2 x 4 m) can be suggested for intercropping under *Melia composita* plantations in initial 2- 4 years.

Kumar (2018) conducted an experiment for evaluation of tree crop interactions in *Melia composita-Tagetes erecta* based agroforestry system at the division of Agroforestry of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. Growth parameters viz height dbh, crown width, volume and above ground biomass of *Melia composita* in pure plantation were not significantly influenced by presence of crop both at the onset of experiment and at the end of the experiment. The height 8.62 m, dbh of 13.41 cm crown width of 7.25 m and aboveground wood biomass 102.61 kg/tree was observed at the end of experiment.

Kumar *et al*. (2018) conducted a field experiment to know the impact of pruning intensity on tree biomass production of *Dalbergia sissoo* and fresh yield of turmeric at the Research Farm, Department of Forestry, College of Agriculture, M.P. The experiment involved four pruning intensities plus open condition. The experiment resulted that canopy spread in both north-south and east-west direction was maximum in no pruning (9.88 m and 9.95 m) whereas lowest in 75 per cent pruning (6.41 m and 6.46 m). Trees having heavy pruning i.e., 75 per cent pruning recorded highest pruned biomass (1085 kg ha^{-1}) as compared to 50 per cent pruning (932 kg ha^{-1}) and 25 per cent pruning (701 kg ha^{-1}). The results also revealed that, 25 per cent pruning recorded higher yield (27.3 q ha^{-1}), as compared to 50 per cent pruning (25.3 q ha^{-1}), over the open condition resulted significantly lowest yield.

2.2 Effect of Pruning and other tree canopy management on growth and biomass

Beadle *et al.* (2019) conducted an experiment to study the effects of pruning on stem form and the incidence of heart rot in an 18-month-old plantation of *Acacia mangium* in south Sumatra to assess whether pruning is associated with an increase in the incidence of heart rot and whether form pruning compared to lift pruning reduced the incidence of heart rot and improved stem form. Form pruning removed 25% of leaf area by removing large branches and those subtending a narrow angle with the stem up to 3 m height, and lift pruning removed 25% of crown length from below. Trees in these treatments were singled before pruning. The third treatment, a control, was not singled and was used to assess base levels of heart rot. No significant difference in diameter increment between the two pruning treatments was found. The results showed that form pruning is likely to have positive benefits on stem straightness and is likely to be effective to any selected pruning height. However a subsequent lift pruning is still considered a requirement.

Pinkard (2002) conducted a study on effects of pattern and severity of pruning on growth and branch development of pre-canopy closure in three 2-year-old *Eucalyptus nitens* in Tasmania. Removing all branches to a predetermined stem diameter versus removing a selection of larger branches from throughout the crown and severity (0–80% leaf area removal) of pruning on stem growth and branch development were studied at over a 15-month period. It resulted that pattern of pruning had only a small effect on stem growth or branch diameter, but removing a selection of branches from throughout the crown resulted in more dead branches than did removing all branches to a pre-determined stem diameter. Stem volume was reduced by selective branch pruning through an initial reduction in diameter and height increment.

Alam *et al*. (2005) studied suitable tree species when subjected to pruning for better output in the homestead agroforestry systems at Kishoregang, Jaldhaka and Domar upazilla of Nilphamari district in Bangladesh. Five tree species viz. *Melia azedarach* (Ghora neem), *Swietenia macrophylla* (Mahogany), *Mangifera indica* (Mango), *Artocarpus heterophyllus* (Jackfruit) and *Psidium guajava* (Guava) were selected and pruning management and the other unpruning condition were

used in the experiment. Pruning started at three years age of saplings. Trees were pruned four times a year at three month intervals. Higher increments in height were observed under pruned conditions viz: *Melia azedarach* (197.83 cm) followed by *Swietenia macrophylla* (57.5 cm), *Psidium guajava* (54.33 cm), *Mangifera indica* (53.33 cm) and *Artocarpus heterophyllus* (48.67 cm). Pruned tree species showed a significant positive increase in circumference compared to those unpruned at 60 cm and 90 cm height from the ground level.

Viquez and Perez (2005) conducted the study on the first results of a pruning trial for *Tectona grandis* L.F. plantations in Costa Rica. Four treatments of pruning heights of 3.0, 4.0, and 5.0 meters, and the control without pruning were taken. Result showed that the initial values of dbh, total height, and stand density were highly uniform among treatments and replication and later differences among treatments in dbh and total height were significant at 3.2, 5.2, 6.1 years but not at 7.3 years.

Chandrashekara (2007) studied the effects of pruning on radial growth increment and leaf twig biomass production in home gardens of Kerala with four pruning intensities on ten locally important tree species (*Ailanthus triphysa, Albizia odoratissima, Artocarpus hirsutus, Bombax malabarica, Bridelia crenulata, Erythrina indica, Grewia tiliifolia, Macaranga peltata, Terminalia paniculata, Xylia Xylocarpa).* The results revealed that certain level of pruning does not promotes stem growth in trees. Instead, the study reflected that in *Ailanthus triphysa* and *Artocarpus hirsutus* annual increment in radial growth was lower in the trees subjected to pruning than that of control while the rest species have a level of pruning that reduces annual increment in stem diameter. Also biomass production was highest in pruned trees.

Handa *et al*. (2007) conducted field experiment under rain fed conditions of Jhansi, Uttar Pradesh to determine pruning intensity and its effect on growth performances of tree species (*Hardwickia binata, Anogeissus pendula, Anogeissus latifolia*) and yield of Black gram. With 4 treatments (10, 25 and 75 %) with 10 % as control. The study resulted that maximum black gram and straw yield was recorded with *Hardwicikia binata* at 75% prunung intensity. No adverse effect was observed with 75 % pruning on tree growth while intercrop was maximum.

Meena (2008) conducted an experiment on Research farm in Department of Forestry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur on different pruning intensities in *Dalbergia sissoo* (no pruning, 25%, 50 % and 75 % pruning). Results showed that more tree height was recorded in 25 % pruning (7.92 m) followed by no pruning (7.47 m) and (50 %) pruning (7.33 m) where 75 % pruning recorded the lowest tree height.

Siddiqui *et al*. (2010) conducted preliminary pruning trial on *Acacia nilotica* (Kikar) at two different sites, in Faisalabad-Pakistan. All pruning treatments resulted in reduction in diameter growth as compared with the control. Also significant reduction in diameter growth was observed when crown removal was more than 40 %. A taper study was done by taking diameter measurements at different heights. The results revealed that pruning treatments have a significant effect on tapering of the stem. At 6 m pruning have a significant effect on diameter growth.

Alcorn *et al*. (2014) examined the effect of 0 %, 20 %, 50 %, and 70 % green crown length removal on growth and wood quality in 3.5-year-old *Eucalyptus pilularis* and *Eucalyptus cloeziana.* With 20 % crown removal growth increment of the stem at breast height was not affected. However, with 50 % crown removal stem increment was reduced for up to 8 months and up to 12 months with 70 % crown removal. Pruning had no impact on height growth but, the height of trees pruned to 70 %, relative to the height of the surrounding unpruned trees, was temporarily reduced 12 months after pruning in both species. Stem form, stem taper, wood density, and residual branch growth above the pruned zone were unaffected by pruning.

Amateis and Burkhart (2016) established an experiment to study the effects of pruning intensity on the growth of *Pinus taeda* L. trees. Trees were planted at a 1.83 by 1.83 m square spacing in plots of eight rows with eight trees per row. Four blocks containing five treatment plots were established at each of two locations in the Virginia Piedmont. The five treatment plots included an unpruned control, and pruning treatments where 1/4 of the live crown was removed on all the trees, 1/2 of the live crown was removed on all the trees, 1/4 of the live crown was removed on 1/2 of the trees, and 1/2 of the live crown was removed on 1/2 the trees. Total

height, dbh, height to base of live crown, crown width within and between the rows was measured at the time of treatment and one year after treatment. The results indicate that pruning trees in a stand at an early age when height growth is vigorous may be viable treatments for improving wood quality and stem form.

Chaturvedi *et al*. (2017) reported that spacing of 5 m x 5 m is optimal while a spacing of 8 m x 8 m is ideal for *Melia dubia* however farmers usually plant at a spacing of 3 m x 3 m or 3 m x 4 m. The spacing followed varies with individual land holding, type of intercropping, availability of water and requirement of the farmer. Annual pruning is done to get straight cylindrical boles and pruning every 6 months controls branching in *Melia dubia.*

Devens (2017) conducted an experiment to study the effects of early pruning on the near-ground branch density of four live fencing species *Vachellia nilotica, Senegalia laeta, Senegalia mellifera,* and *Prosopis juliflora*. Physical measurements and photographic data indicated that after one growing season, *Vachellia nilotica* was a superior thorny hedge species with significantly higher values in all metrics, while *Prosopis juliflora* performed poorly in all metrics. Pruning treatments did not increase branch density compared to control treatments.

Patel *et al*. (2017) conducted a study to determine the impact of pruning and agronomical management on wood production and yield of paddy under *Dalbergia sisoo* at the Department of Forestry, College of Agriculture, and Jabalpur (M.P.) during, *kharif* season of 2014. The experiment involves four pruning intensities one open (without tree) in main plot and three agronomical management practices. It resulted that the diameter at breast height of tree was significantly influenced by different pruning treatments. 25 % pruning recorded significantly higher dbh (23.98 cm). The cylindrical volume and stand biomass of tree significantly influenced by different pruning treatments, 25 % pruning recorded significantly higher cylindrical volume and stand biomass which was significantly superior to 75 % pruning and at par with no pruning and 50 % pruning. The study resulted that shade of trees adversely affects growth and yield of crop but pruning can reduce tree canopy, facilitated entry of sunlight, pruning is one of them

Takiya *et al*., (2017) examined the effect of early and intense pruning in young hybrid larch (*Larix gmelinii* var. japonica 9 L. kaempferi) to establish a new

effective management method for hybrid larch plantations. The growth parameters were measured and resulted that rates were lower in the heavy pruning treatment 4 m above the ground level than in other treatments in the year following pruning, when measured 4 years later, growth did not differ between treatments.

Kumar *et al*. (2017) developed high yielding varieties of *Melia dubia* in Forest Research Institute, Dehradun by Initiating genetic improvement of *Melia dubia* with selection of plus tree using index method. A total of 230 genetically divergent plus trees (CPTs) of the species were selected based on growth parameters like height, dbh, straightness, CBH, CD, Knots, biomass estimation and genetic worth of plus trees was evaluated by establishing progeny trails at various geographical locations and was concluded that sharad cultivar has maximum productivity being 55.83 m^3 $ha^{-1}yr^{-1}$ followed by 40.41 m^3 ha^{-1} yr^{-1} shashi and mentioned that Melia has become an extremely important industrial wood and is being grown now even by farmers under various agroforestry systems.

Jarvis and Marlow (2000) studied cores from the trunks of thirty-five pollarded and thirty-five unpollarded lime trees (Tilia x europaea) in Kidderminster, Worcestershire, and annual growth rings were measured. The act of pollarding led to an initial growth spurt then, for a few years, a relative decline in trunk growth rate. Data suggest that weather, especially temperature and rainfall regimes of the preceding seasons, together with a range of site effects, including inter-tree spacing and soil, had a greater impact on annual trunk growth than pollarding.

Thakur and Sehgal (2003) studied growth, leaf gas exchange and production of biomass in coppiced and pollarded agroforestry tree species. Stem cut at heights of 0.5, 1.0, 1.5 and 2.0 m were applied to four species namely *Grewia optiva*, *Celtis australis, Bauhinia variegate and Morus alba*. It resulted that LAI, transpiration and photosynthetic rate was highest at cutting heights of 1.5 m in *Morus alba.* Coppicing and pollarding significantly affected the production of foliage and branch wood biomass.

Islam *et al*. (2008) investigated the effects of pruning and pollarding on shoot development in *Sesbania grandiflora* L. in Bangladesh Agricultural University. The results revealed that the severely pruned plant (both lower and upper branch pruned along with pollarded shoot tip) not only produced huge

amount of shoot biomasses but also enhance the development of new shoots within a very short period

Tree canopy management practices not only affect the growth but biomass as well. There are numerous such reports in literature where it has been reported that these management practises influence the biomass production.

Biomass production in the under storey is a function of photosynthetically active radiation (PAR) falling on the ground surface (Hazra and Tripathi. 1986).

Toky and Bisht (1993) conducted a study to compare the biomass accumulation in 6-yr-old trees of nine important fuel wood species from arid north-western India. The study results showed wide variation in above ground biomass accumulation which varied from 11.6 kg tree^{-}1 in *Zyziphus mauritiana* to 37.5 kg tree^{-}1 in *Melia azedarach*.

Elfadl *et al*. (2003) conducted an experiment to study the effects of pruning on biomass growth in *Prosopis juliflora* which were examined in dryland conditions in Teliebat Sudan. Growth parameters were followed for 32 months and heavily pruned trees yielded more than six times larger usable wood volume and produced 60% more leaf biomass than the unpruned. Also in pruned trees photosynthetic efficiency, water status was significantly higher with more efficient CO_2 assimilation rate, associated with higher stomatal conductance.

Tipu *et al*. (2006) conducted a study on the effect of pruning height on shoot biomass yield of *Leucaena leucocephala* in agroforestry farm, Bangladesh Agricultural University with four treatment pruning heights; 3-5 (basal cut), 50, 100 and 150 cm above the collar zone. Yield of shoot biomass increased greatly with the increase in pruning heights. Higher number of branches, longer length of branches and maximum leaves per plant than those of the lower heights was observed. The 150 cm pruning height was found to yield the highest biomass followed by the 100 cm height. Thus it was concluded that a higher pruning height should be practiced in Leucaena for higher shoot biomass yield.

Newaj *et al*. (2007) studied canopy pruning on biomass production in *Albizia procera* and revealed that growth and biomass production accumulation in Albizia was higher in control unpruned trees than 50% and 70 % canopy pruning.

The biomass of herbaceous layer was significantly higher in 70% canopy pruning than 50% canopy pruning and control. The biomass of herbaceous layer in 70% pruning was about 2 times higher than control.

Roy *et al*. (2006) studied tree growth and biomass production in eight year old plantation in single line (2 m apart) of *Melia azedarach* tree on farm boundaries in a semi-arid region of Jhansi, U. P and resulted that maximum number of trees were recorded in the diameter range of more than 22 cm and the trees contributed a total biomass production of 2101 t ha^{-1} of which 66, 11 24 and 10 % were contributed by minor timber, fire wood and fodder respectively.

Mir (2010) conducted a study to estimate above ground biomass and rate of carbon sequestration in *Tectona grandis, Madhuca indica, Dalbergia sissoo, Acacia nilotica,* and *Azadirachta indica* at Allahabad. The study resulted that *Madhuca indica* have maximum above ground biomass followed by *Azadirachta indica*, *Dalbergia sissoo, Tectona grandis* and *Acacia nilotica* with 398.84, 306.86, kg $tree^{-1}$ respectively, also the total carbon sequestration rate obtained from above ground biomass of *Tectona grandis*, *Madhuca indica* and *Azadirachta indica* were 11.94, and 15.67 kg $tree^{-1}$ respectively.

Naugraiya *et al.* (2018) studied biomass, nutrient accumulation and soil improvement in eighteen years old plantation of *Azadiractha indica* at Research Farm, Baronda (Raipur) Chattisgarh at 3×3m spacing. The experiment resulted in 62.07 kg $tree^{-1}$aboveground biomass.

Roshanzada *et al*. (2018) studied growth and carbon storage potential of important agroforestry trees of north-west Himalaya at Dr Y S Parmar University of Horticulture and Forestry, Nauni area, Solan Himachal Pradesh, India. Total seven species including 210 trees were selected in the study. The result revealed that above ground biomass and carbon stored in *Melia composita* was 950 kg/tree and 475 kg/tree.

Chauhan *et al*. (2019) conducted an experiment at the University Seed Farm, Ladhowal, Ludhiana Punjab to study tree biomass and carbon sequestration in four short rotation tree plantations (*Acacia catechu, Dalbergia sissoo, Melia azedarach*

and Terminalia arjuna). The maximum aboveground biomass 261.40 t ha-1 was recorded in *Terminalia arjuna* whereas minimum 96.58 t ha-1 in *Melia azedarach*.

Das *et al*. (2019) studied the performance and characterize plant growth behaviour, light profile and soil fertility status of multipurpose trees species in Ranchi, Jharkhand and resulted that biomass production and higher photosynthetically active radation potential of *Gmelina arborea, Dalbergia sissoo* and *Leucaena leucocephala* was higher. Also a significant increase in pH and decrease in EC of trees were observed and indicated that a need for replenishment of nutrients in soil for maintaining soil fertility in agroforestry systems.

Dilla *et al*. (2019) conducted a study in agroforestry parklands in Ethopia and many parts of the tropics and a number of *Faidherbia albida* trees and soil from Adulala. Watershed was sampled to provide a preliminary estimate of the C sequestration potential of these systems. Selected albida trees within an area of 79 hectares had been pruned 2-4 years earlier, and canopies had since regrown and both height and diameter was measured. The study has evaluated that albida trees in the study stored about 2 t C ha^{-1} in above ground biomass, but several studies report that albida trees parkland systems can store more C in their aboveground biomass.

Light transmission ratio (%)

Sequeria and Gholz (1991) proved that tree crown area is the most important crown related parameter determining the light penetration and tree growth. It was observed that light penetration decreased as crown area increased.

Sharma and Singh (2005) studied high-density orchard of 16-year-old (Amrapali) mango trees at the Indian Agricultural Research Institute New Delhi. Trees were pruned by tipping or by removal of 4, 8 or 12 inches from the apex of each branch. The light penetration and rate of photosynthesis were increased with the extent of pruning, but the specific leaf weight was not affected. The leaf chlorophyll contents were higher in unpruned and tipped trees than in pruned. The rate of photosynthesis and leaf chlorophyll contents was greater in leaves that developed on the south east side of the tree canopy than on the other sides.

Chapter-3

Material and Methods

CHAPTER-3

MATERIALS AND METHODS

The present study entitled **"EFFECT OF PRUNING ON GROWTH CHARACTERISTICS OF *Melia composita*"** was conducted at experimental farm at the Division of Agroforestry, Sher – e – Kashmir University of Agricultural Sciences and Technology of Jammu during the period from April 2018 - July 2019. The details of the experimental site, materials used and methodology followed during the course of investigation are given here under the following headings:

3.1 Experimental site

3.2 Experimental details

3.3 Experimental observations

3.4 Statistical analysis

3.1 Experimental site

3.1.1 Location

The present investigations were carried out at the experimental farm of the Division of Agroforestry Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. It is located at 32^0- 40 ′ N latitude and 74 ^{0}-58′ E longitude at an elevation of 332 meters above mean sea level.

3.1.2 Climate and weather conditions

Jammu being a subtropical region experiences hot dry summers, humid rainy season as well as cold months. The summer season usually starts from April and lasts up to June. The maximum temperature rises upto 45 $^{\circ}$ C during May to June and minimum falls to 1 $^{\circ}$ C during winter. The average annual rainfall ranges from 1000 – 1250 mm with 75 - 80 per cent of which is received during July to September and rest 20 - 25 per cent during winter months of December to February. The weather data

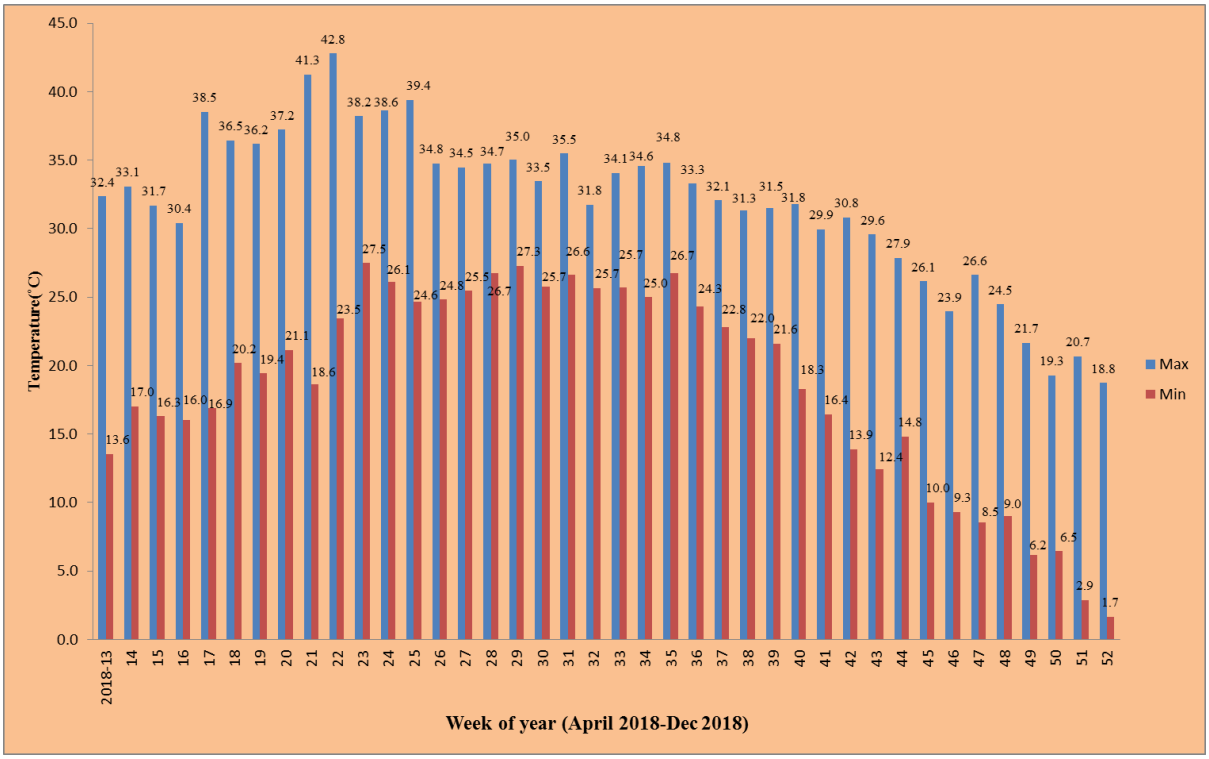
recorded at meteorological observatory of SKUAST-Jammu, Chatha, for the study period is given in figures 3.1 - 3.8.

3.1.3 Soil characters

In order to determine the status of the soil in the experimental area soil samples were collected from the different locations within the experimental field, which were taken randomly at the beginning and end of the experiment and were analyzed for the purpose of evaluating the status of soil. The soil was sandy loam in texture. The test analysis revealed the following values for different parameters. (Table 3.1).

Table 3.1 Soil properties of the experimental site at the beginning of the experiment

At the beginning of the experiment			
S.No	**Parameters**	**Test value**	**Method employed**
1	Organic Carbon (g/kg)	4.11	Rapid titration method (Walkey and Black, 1934)
2	Available Nitrogen (kg/ha)	243.25	Alkaline potassium permanganate method (Subbiah and Asija,1956)
3	Available phosphorus (kg/ha)	17.02	Olsen *et al*.(1954)
4	Available potassium (kg/ha)	134.85	(Merwn and Peach, 1951)
At the end of the experiment			
1	Organic Carbon (g/kg)	4.78	Rapid titration method (Walkley and Black,1934)
2	Available Nitrogen (kg/ha)	245.5	Alkaline potassium permanganate method (Subbiah and Asija,1956)
3	Available Phosphorus (kg/ha)	13.74	Olsen *et al*.(1954)
4	Available potassium (kg/ha)	131.87	(Merwin and Peach,1951)



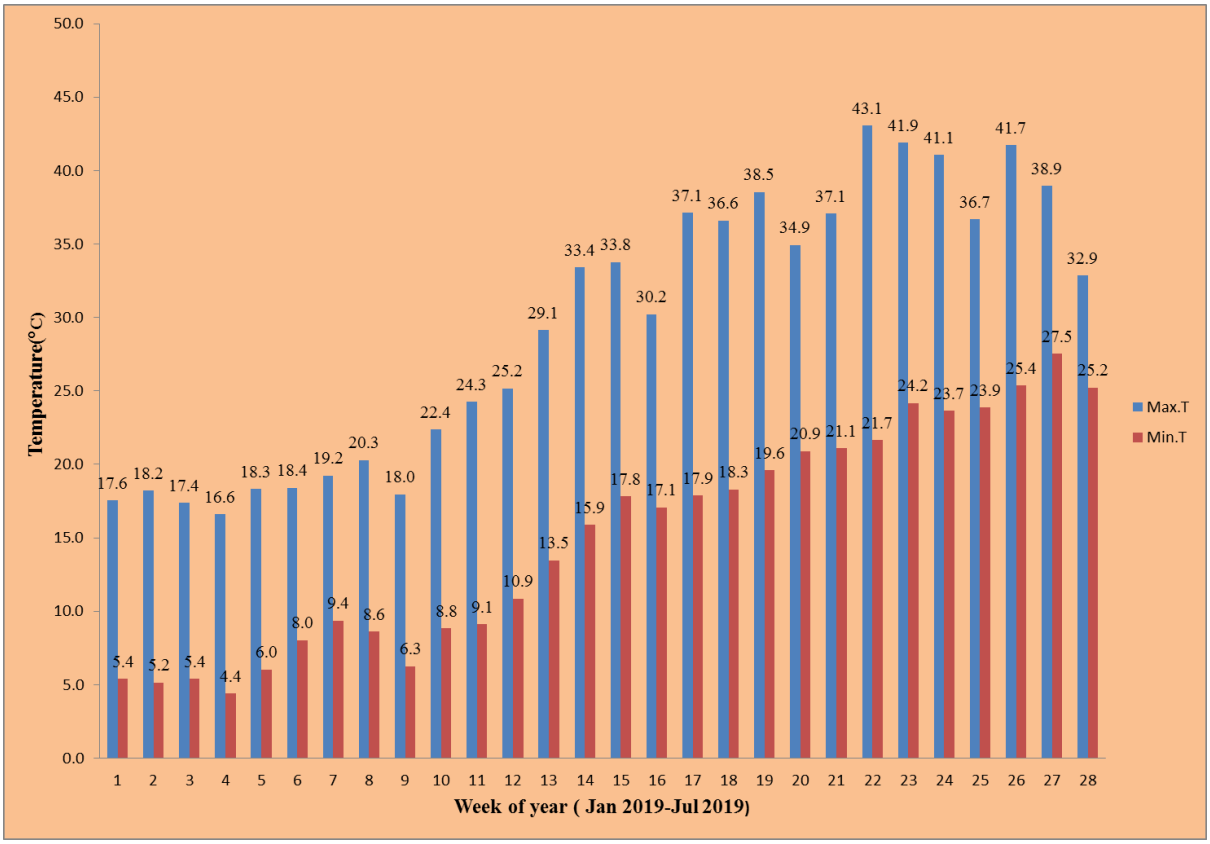
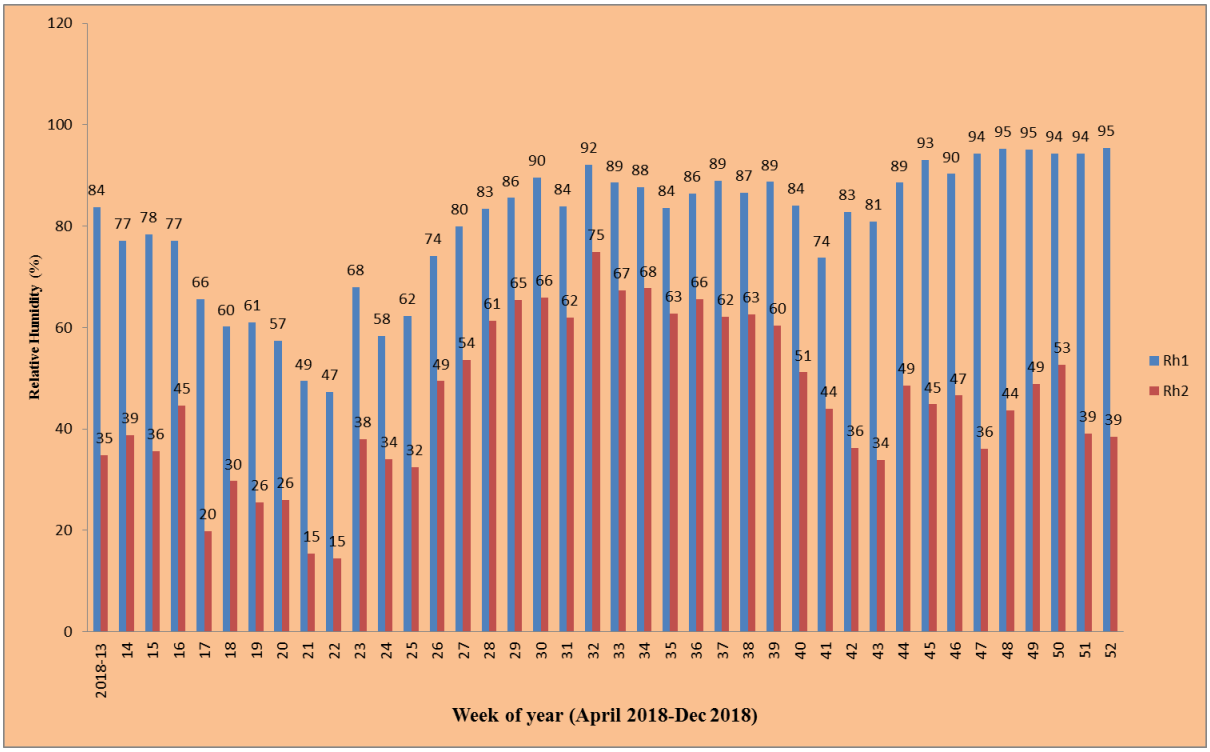


Figure 3.1and figure 3.2 Weekly average temperature



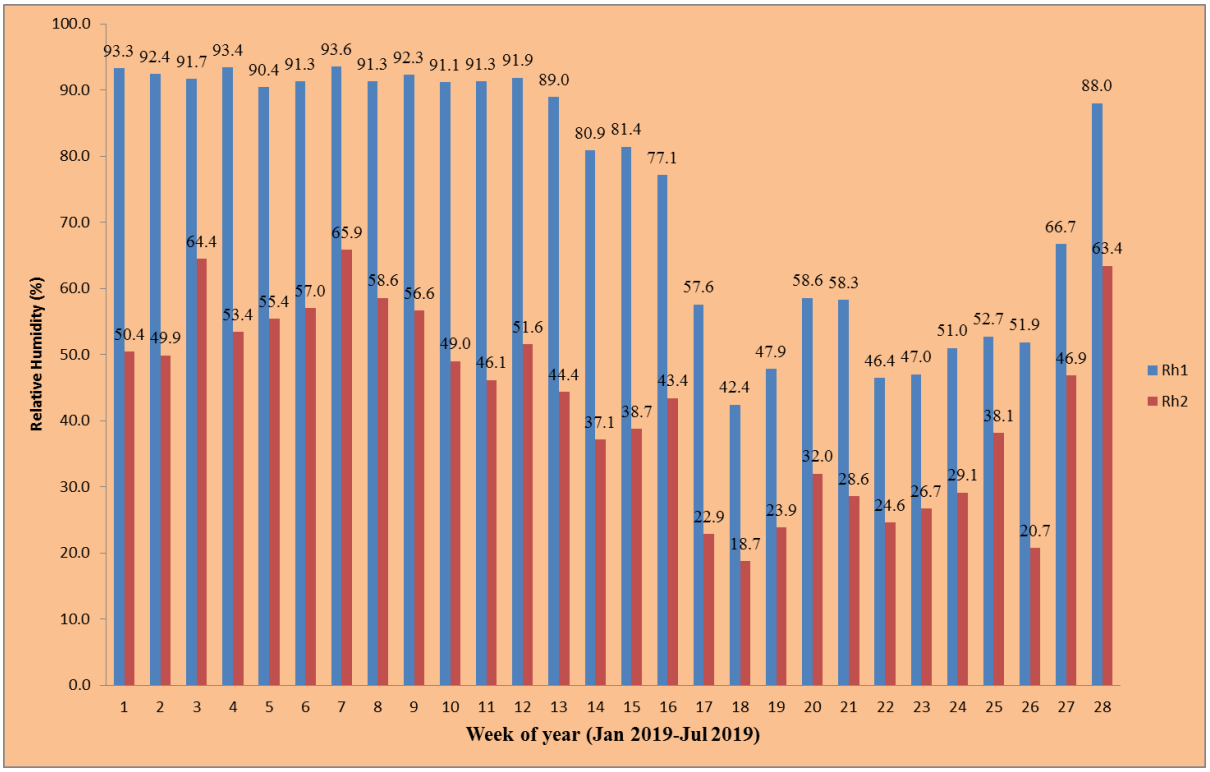
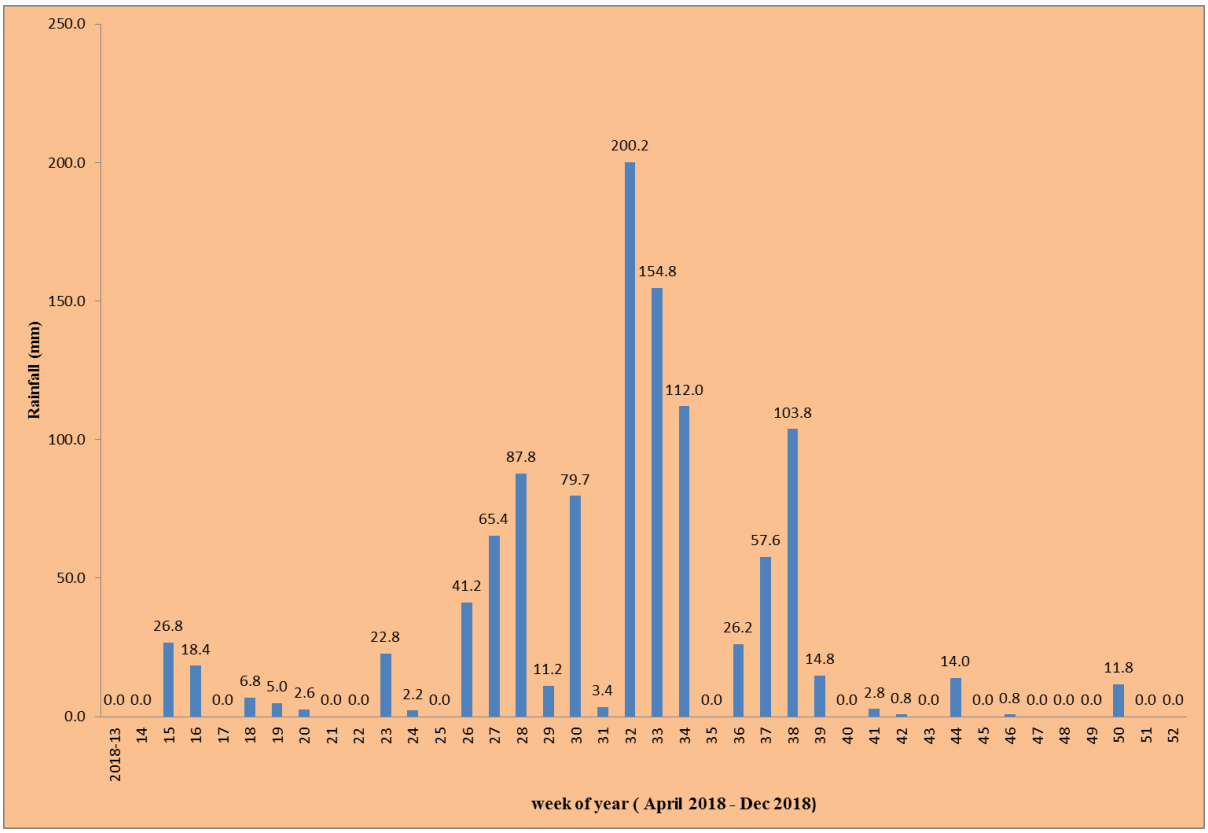


Figure 3.3 and 3.4 Weekly average humidity



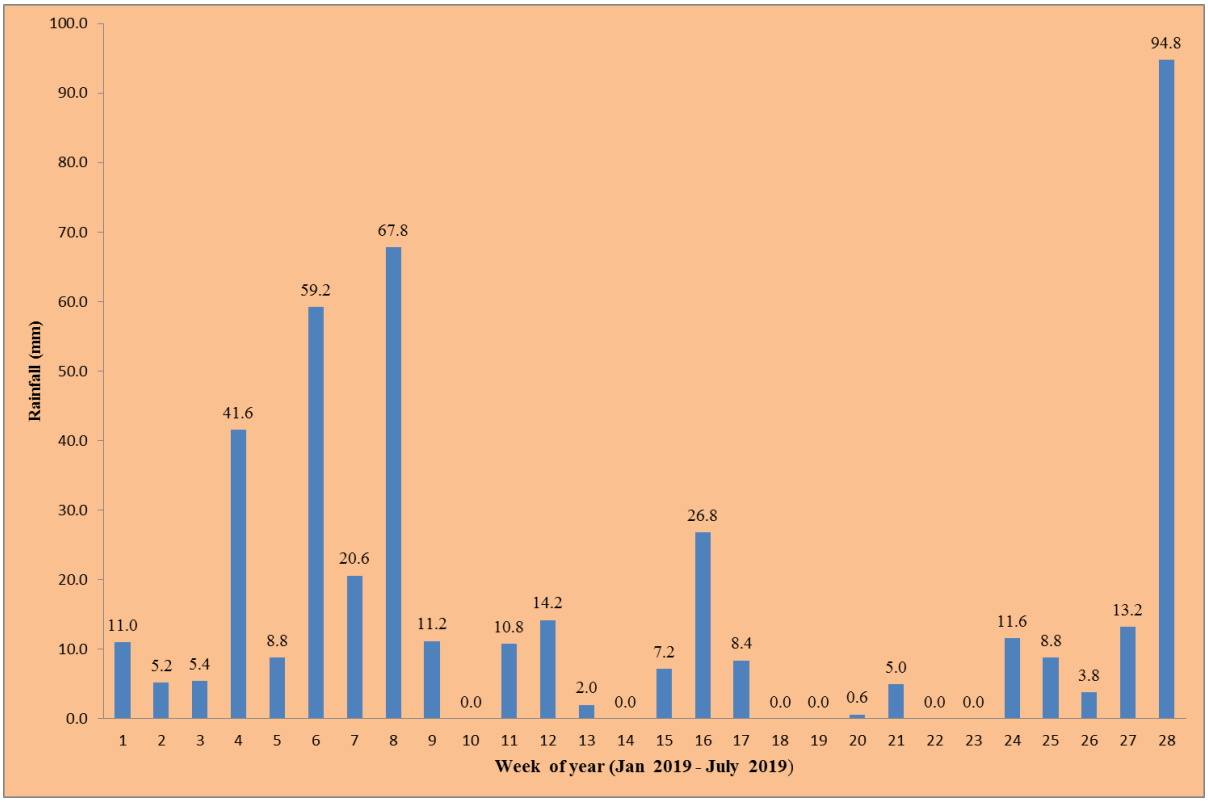
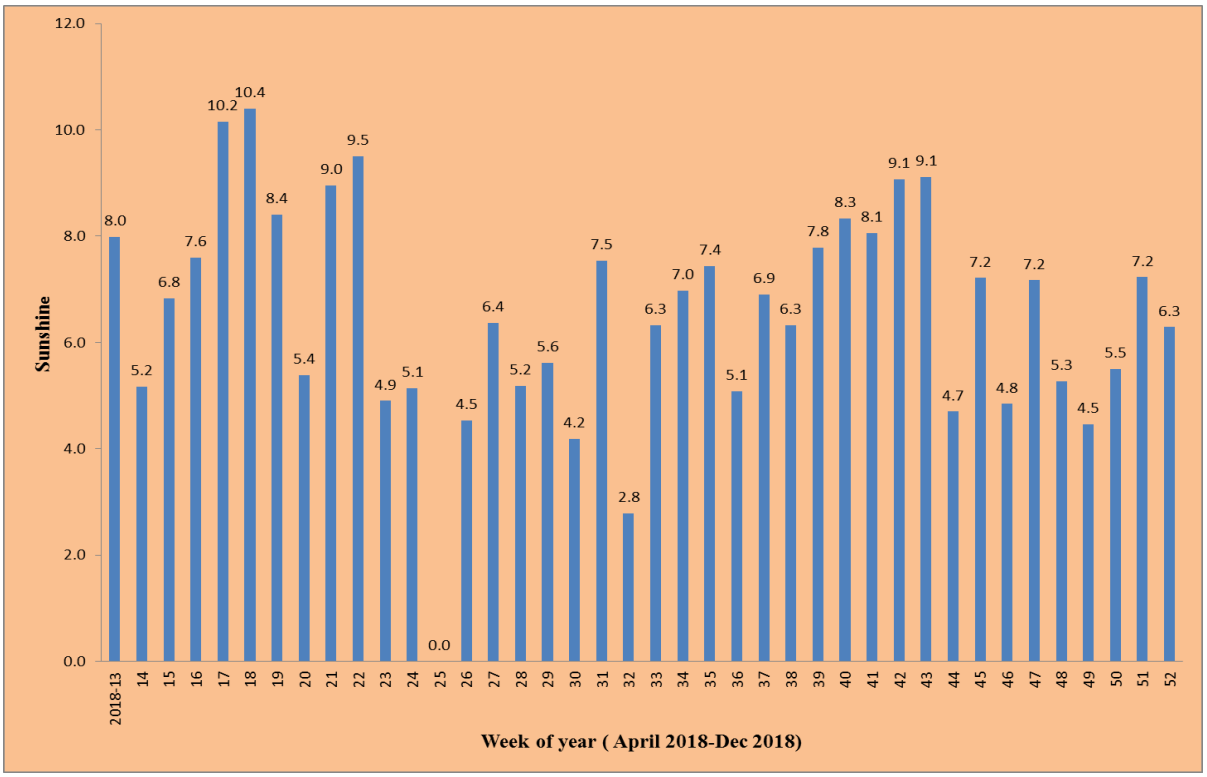


Figure 3.5 and 3.6 Weekly average rainfall



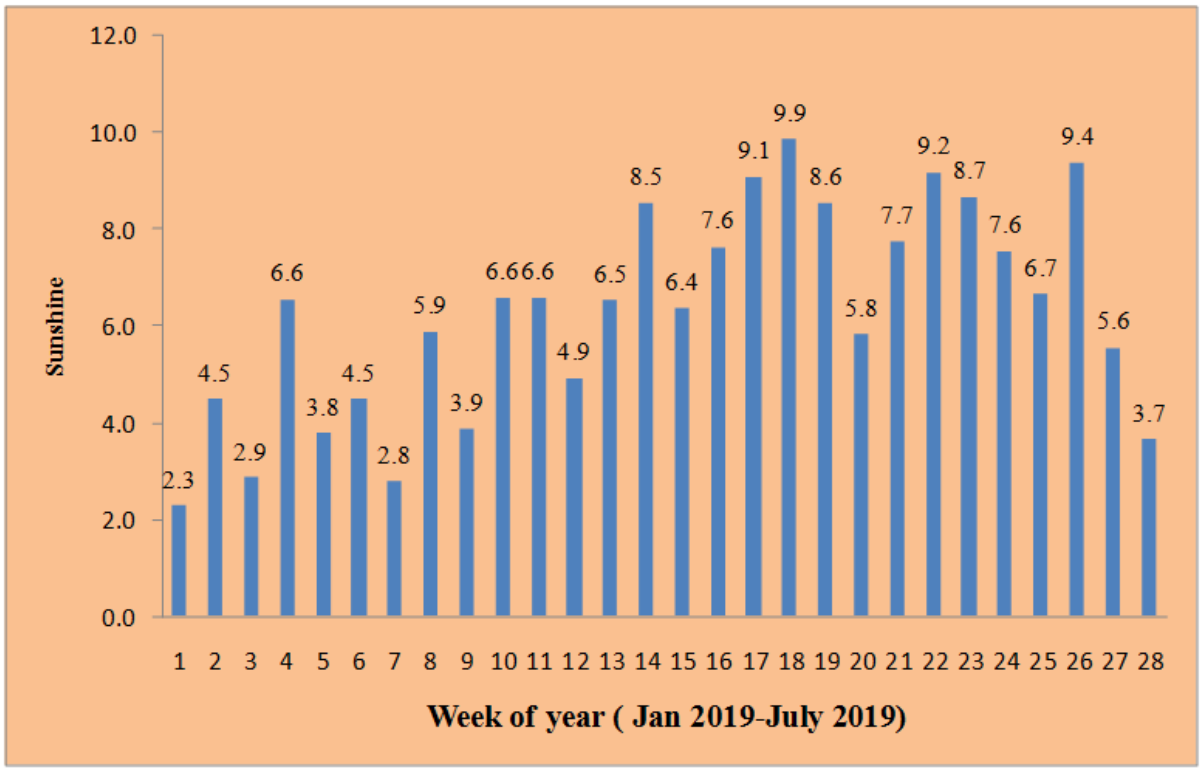


Figure 3.7 and 3.8 Weekly average sunshine

3.2 Experimental details:

The present study was undertaken at the Experimental farm, Division of Agroforestry with spacing of 6m × 4m on 2.5 years old *Melia composita* trees, planted during the year 2016. Melia was planted in two blocks. In the first block, *Melia composita* saplings were planted as such (T_1) where as in the second block, the lower branches of Melia *composita* were pruned, debranched and only 3 - 4 branches were kept (T_2). In these two blocks, selected trees were topped off by cutting off the main stem at 3.50 m height. Treatment (T_3) refers to the topped off in the first block i, e (T_1) whereas (T_4) refers to the topped off (T_2) trees in the second block. The study was initiated during the time period April 2018 to July 2019. Selected trees per treatment were marked and tagged for recording the observations throughout the study period. The growth characteristics and light interception on *Melia composita* was recorded for individual tree from each block and mean value was worked out .

3.2.1 Layout of experiment:

Location : Experimental farm of the Division of Agroforestry
SKUAST-Jammu

- Species : *Melia composita*
- Spacing of tree : Row to Row: 6m×6m
  Tree to Tree: 4m×4m
- Number of trees per plot : 120
- Age of plantation : 2.5 Years
- No of treatments : 04
- Treatments details :
  T_{1-} No pruning
  T_{2} - Pruning of lower crown
  T_3 - Topping off T_1
  T_4 - Topping off T_2
- Replications : 0 5
- Statistical Design : Randomized Block Design (RBD)

3.3.3 Experimental observations

The observations on different growth characteristics of *Melia composita* were recorded during the course of investigation and the procedures adopted are given below. Five Trees were randomly selected from each block of each replication and the following observations were recorded.

- Tree height (m)
- Diameter at breast height (cm)
- Crown spread (m)
- No. of branches
- Above ground biomass of standing trees (Kg)
- Light transmission ratio %
- Leaf area (cm^2)
- Leaf chlorophyll content %

3.3.1. Tree height (m)

Five trees were tagged by randomly selecting from each treatment in the experimental area and total height of trees selected for the experiment was measured from base to the tip using Ravi altimeter for all treatments and was measured in meter. Average values were then calculated.

3.3.2. Diameter at breast height (cm)

The diameter at breast height (dbh) of selected trees was measured at breast height (1.37m) of selected trees with the help of tree caliper and expressed in centimeter (Chaturvedi and Khana, 2007). Five trees were tagged by randomly selecting from each treatment in the experimental area and the measurements for diameter at breast height were taken. Average values were then calculated.

3.3.3. Crown spread (m)

The crown spread of tree was measured in East –West and North –South direction of the tree trunk. It was measured with the help of a properly graduated tape. Average values were then calculated (Landol, 2014).

$$CS = \frac{D_1 + D_2}{2}$$

where,

CS = Crown Spread

D_1 = Crown spread in north – south direction (m)

D_2 = Crown spread in east – west direction (m)

3.3.4. No. of branches

The total numbers of branches per tree were recorded by counting the number of lateral branches of five selected trees from each treatment and average values per tree were calculated.

3.3.5. Total tree above ground biomass of standing trees

Non destructive method for estimation of above ground tree was adopted.

Stem biomass

The biomass of the standing tree was determined by multiplying volume and oven dry wood specific gravity (Shah *et al.*, 2014). The wood specific gravity was estimated following IS. 2455(1990).

Volume = Basal Area× Height × Form factor

Branch biomass

For branch biomass estimation two branches per tree were randomly selected and were used to estimate the fresh biomass. The samples were then oven dried to

estimate the oven dry weight. This was later multiplied with the number of branches in each tree to obtain total branch biomass per tree.

Total above ground biomass = Stem biomass + branch biomass

3.3.6 Light transmission ratio %

The light transmission ratio was estimated by measuring the illuminace with the help of digital illuminance meter (TES-1332A) strictly on cloudless days. The readings were made in order to estimate light intercepted by the *Melia composita* trees. One reading was taken in the open, away from the tree and four readings were taken under the tree canopy (Dhandayuthapanil *et al*., 2015). This was repeated for all the treatments. All measurements were taken on uniformly overcast days between 10.00 and 12.00 hours during the period of study.

Light transmission ratio (LTR) was calculated from the readings taken in the open and beneath canopy by using the following formula:

$$\text{Light Transmission Ratio (\%)} = \frac{\text{Total radiation beneath canopy}}{\text{Total solar radiation in open}} \times 100$$

3.3.7 Leaf area (cm^2)

Al the green leaves were categorized into small, medium and large from the marked trees. Then five leaves from each tree were taken and their actual area was determined with the help of graphic method and their calculated area was determined with the help of maximum length and max width method. Maximum leaf length was, measured from juncture to tip and maximum width was taken from center of the leaves. The correction factor was obtained by dividing the actual area by calculated area. Leaf area was then obtained by multiplying the calculated area with the correction factor.

3.3.8 Leaf chlorophyll content (%)

Leaf chlorophyll content was measured with the help of SPAD-502 plus chlorophyll meter and expressed as average chlorophyll content of leaves in per cent.

SPAD-502 is a hand- held, self-calibrating device that is widely used for the rapid, accurate and non-destructive measurement of leaf chlorophyll concentrations (Ling *et al*., 2011).

3.4. Statistical analysis

The entire data generated from the present investigations were analysed statistically using the technique of analysis of variance for Randomized Block Design (RBD) design using the technique of analysis of variance (ANOVA) in accordance procedure outlined by Gomez and Gomez (1984). The effect of different treatments was tested at 0.05 level of significance. Suitable graphical presentations based on the data are given at the appropriate places.

Plate 1

Plate 2

Plate 3

Plate 4

Chapter-4

Results

CHAPTER-4

EXPERIMENTAL RESULTS

The present investigation entitled **"EFFECT OF PRUNING ON GROWTH CHARACTERISTICS OF *Melia composita*"** was conducted at the experimental farm, Division of Agroforestry SKUAST-Jammu. The data recorded on various parameters has been analyzed and results so obtained are presented under different sub headings with appropriate figures and tables.

4.1. Growth parameters of *Melia composita.*

4.1.1 Tree height (m)

The mean data collected regarding the effect of various treatments of initial pruning on the height of *Melia composita* have been presented in table - 4.1. It reveals that the tree height was significantly affected by various treatments. In the month of April the maximum (7.50 m) tree height was recorded in treatment T_1 which was statistically at par (7.24 m) with treatment T_2 whereas the tree height of T_3 (3.42 m) was statistically at par (3.04m) with treatment T_4 recording the minimum average tree height.

The tree height in July 2018 showed a similar trend. Maximum (8.08 m) tree height was recorded in treatment T_1 which was statistically at par (7.98 m) with treatment T_2 whereas, tree height of 4.20 m was recorded in treatment T_3 and the minimum tree height (3.0 m) was recorded in treatment T_4 (Table - 4.1).

During April 2019 the maximum (9.30) tree height was recorded in treatment T_1 which was statistically at par (8.72 m) with treatment T_2. In treatment T_3 the tree height was (5.20 m) and minimum average tree height (4.28 m) was recorded in treatment T_4 as presented in table - 4.1.

In the month of July 2019 the data presented in table - 4.1 reveals that the tree height was maximum (11.80 m) in treatment T_1 followed by treatment T_2 (9.94 m). In

treatment T_3 the tree height was (5.24 m) whereas minimum (4.28 m) average tree height was recorded in the treatment T_4.

Table 4.1 Effect of different treatments on height of *Melia composita* (m)

TREATMENT	Tree height (m)			
	April 2018	**July 2018**	**April 2019**	**July 2019**
T_1	7.50	8.08	9.30	11.80
T_2	7.24	7.98	8.72	9.94
T_3	3.42	4.20	5.08	5.24
T_4	3.04	3.36	4.18	4.28
CD(0.05)	0.78	0.74	0.45	0.51

4.1.2 Diameter at breast height (cm)

The data pertaining to the diameter at breast height during the present study is recorded and presented in table- 4.2. The reduction in diameter was evident but non significant for all treatments when compared to control. The observation for the month of April 2018 shows that diameter at breast height was highest for treatment T_1 (20.7 cm) followed by treatment T_3 (18.6cm) which was further followed by T_2 (18.5 cm) and the minimum diameter at breast height was recorded in treatment T_4 (18.4 cm).

In the month of July 2018 the maximum (21.5 cm) diameter at breast height was recorded in treatment T_1 followed by treatment T_2 (19.4 cm) further followed by T_3 (19.1 cm) and the minimum average diameter at breast height (18.6 cm) was recorded in treatment T_4 (table - 4.2).

During April 2019 the data for diameter at breast height reveals that the maximum diameter at breast height of (22.5 cm) was recorded in treatment T_1 followed by treatment T_2 (19.7 cm) which was further followed by T_3 (19.1 cm) and the minimum (19.0 cm) average diameter at breast height was recorded in treatment T_4 (Table - 4.2).

In the month of July 2019 the data pertaining to the diameter at breast height was recorded and is presented in table - 4.2. The maximum (22.7 cm) diameter at breast height was recorded in treatment T_1 followed by treatment T_2 (20.6 cm) which was further followed by T_3 (20.4 cm) and T_4 recording minimum (20.3 cm) average diameter at breast height. Overall, the effect of different treatments on diameter at breast height was found to be statistically non-significant.

Table 4.2 Effect of different treatments on Diameter at breast height of *Melia composita* (cm)

TREATMENT	Diameter at breast height (cm)			
	April 2018	**July 2018**	**April 2019**	**July 2019**
T_1	20.7	21.5	22.5	22.7
T_2	18.5	19.4	19.7	20.6
T_3	18.6	19.1	19.1	20.4
T_4	18.4	18.6	19.0	20.3
CD(0.05)	N.S	N.S.	N.S.	N.S

4.1.3 Crown spread (m)

The crown spread was significantly affected by various treatments during the study period. In the month of April the maximum (5.92 m) crown spread was recorded in treatment T_1 followed by treatment T_2 (4.57 m) further followed by T_3 (0.22 m) which was statistically at par (0.16 m) with treatment T_4 (Table 4.3).

A similar trend was observed in the month of July 2018 (Table 4.3).

In the month of July 2018 recorded data in table - 4.3 showed that the tree crown spread was maximum (6.21 m) in treatment T_1 which was statistically at par (4.60 m) with treatment T_2. The crown spread in treatment T_3 (0.87 m) was statistically at par (0.68 m) with treatment T_4 which recorded the lowest values for the crown spread.

Results obtained in the month of April 2018 as presented in table - 4.3 revealed that crown spread was maximum (6.66 m) in Treatment T_1 followed by treatment T_2

(5.02 m) whereas in treatment T_3 crown spread was 2.01 m which was statistically at par (1.78 m) with treatment T_4 which recorded the minimum crown spread.

In the month of July 2019 the data presented in table - 4.3 revealed that the crown spread was maximum (7.12 m) in treatment T_1 followed by treatment T_2 (5.55 m) which was further followed by treatment T_3 (2.91 m) and the minimum (2.46 m) crown spread was recorded in the treatment T_4.

Table 4.3 Effect of different treatments on crown spread of *Melia composita* (m)

TREATMENT	Crown spread (m)			
	April 2018	July 2018	April 2019	July 2019
T_1	5.92	6.21	6.66	7.12
T_2	4.57	4.60	5.02	5.55
T_3	0.22	0.87	2.01	2.91
T_4	0.16	0.68	1.78	2.46
CD(0.05)	0.37	0.34	0.55	0.44

4.1.4 Number of branches per tree

The data with respect to number of branches per tree of different treatment is presented in table - 4.4. It reflected that the number of branches was significantly influenced by the different treatments. In April 2018, the mean number of branches per treatment were maximum (26.48) for treatment T_1 followed by treatment T_2 (21.68). The minimum numbers of branches were observed in treatment T_4 (2.36) which were statistically at par (2.48) with treatment T_3.

In the month of July 2019 the recorded data presented in table - 4.4 reveals that the maximum (33.40) number of branches were recorded in treatment T_1 which was statistically at par (19.76) with treatment T_2. In treatment T_3 the number of branches (4.60) was statistically at par (4.48) with treatment T_4.

The data recorded in the month of April 2019 as presented in table - 4.4 showed that number of branches were maximum (35.60) for Treatment T_1 followed by treatment

T_2 (21.60). However, statistically there was no difference in treatment T_3 and T_4 as far as the number of branches was concerned.

A similar trend was observed in the month of July 2019.The data presented in table - 4.4 reveals that the maximum (36.20) number of branches was recorded in treatment T_1 followed by treatment T_2 (27.44) whereas the treatment T_3 and T_4 were statistically at par (Table 4.4).

Table 4.4 Effect of different treatments on number of branches of *Melia composita*

TREATMENT	Number of branches			
	April 2018	**July 2018**	**April 2019**	**July 2019**
T_1	26.48	33.40	35.60	36.20
T_2	21.68	19.76	21.60	27.44
T_3	2.48	4.60	16.20	25.40
T_4	2.36	4.48	15.04	24.60
CD(0.05)	16.42	13.98	8.35	5.49

4.1.5 Above ground biomass (kg) of *Melia composita*

The data pertaining to the above ground biomass is presented in table 4.4. A reduction in above ground biomass was evident for all treatments when compared to control. The observation for the April 2018 is maximum (89.90 kg) for treatment T_1 which was statistically at par with treatment T_2 (84.43 kg). Due to topping off treatment T_3 recorded (32.01 kg) above ground biomass and T_4 (31.70 kg) recorded the minimum biomass.

In the month of July 2018 the recorded data presented in table - 4.4 reveals that the maximum (96.04 kg) aboveground biomass was recorded in treatment T_1 which was statistically at par (94.72 kg) with treatment T_2. In treatment T_3 (32.77 kg) aboveground biomass was recorded which was statistically at par (32.68 kg) with treatment T_4.

For the April 2019 above ground biomass was found maximum (102.93 kg) for Treatment T_1 followed by treatment T_2 (96.56 kg). In treatment T_3 (34.08 kg) above ground biomass was statistically at par (33.66 kg) with treatment T_4 (Table-4.8).

In the month of July 2019 the data presented in table- 4.4 reveals that the maximum (111.64 kg) above ground biomass was recorded in treatment T_1 which was statistically at par (110.34 kg) with treatment T_2. In treatment T_3 (36.43 kg) above ground biomass was statistically at par (35.33 kg) with treatment T_4.

Table 4.5 Effect of different treatments on above ground biomass (kg) of *Melia composita*

TREATMENTS	Above ground biomass (kg)			
	April 2018	**July 2018**	**April 2019**	**July 2019**
T_1	89.90	96.04	102.93	111.64
T_2	84.43	94.72	96.56	110.34
T_3	32.01	32.77	34.08	36.43
T_4	31.70	32.68	33.66	35.33
CD (0.05)	5.08	4.47	4.88	6.18

4.1.6 Light transmission ratio (%)

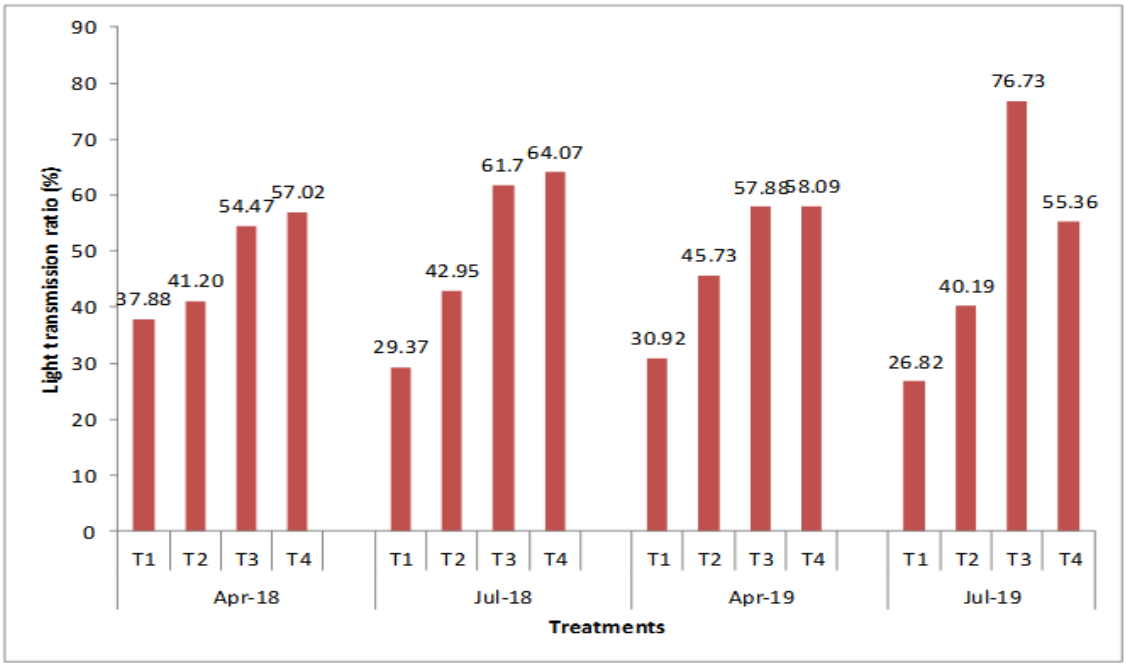
The Light transmission ratio of *Melia composita* was measured from different treatments and is presented in figure - 4.1. It resulted that the Light transmission ratio was significantly affected by different treatments. In the month of April 2018 the light transmission ratio was maximum (57.02 %) for treatment T_4 followed by treatment T_3 (54.47 %) which was statistically at par (41.20 %) with treatment T_2. Treatment T_1 recorded minimum (37.88 %) light transmission ratio.

Results for the month of July 2018 as presented in figure - 4.1 showed that light transmission ratio was maximum (64.07 %) for treatment T_4 followed by treatment T_3 (61.70 %). In treatment T_2 light transmission ratio was (42.95 %) and the minimum (29.37 %) light transmission ratio was recorded in treatment T_1.

For the April 2019 light transmission ratio was found maximum (58.09 %) for Treatment T_4 followed by treatment T_3 (57.88 %). In treatment T_2 light transmission ratio was (45.73 %) and minimum (30.92 %) light transmission ratio was recorded in treatment T_1 (figure - 4.1).

Results for the month of July 2019 as presented in figure - 4.1 showed that light transmission ratio was maximum (76.73 %) for Treatment T_3 which was followed by treatment T_4 (55.36 %). In treatment T_2 light transmission ratio (40.19 %) was statistically at par (26.82 %) with treatment T_1.

Fig. 4.1: Effect of different treatments on light transmission ratio (%) of *Melia composita*



4.1.7 Leaf Area (cm^2)

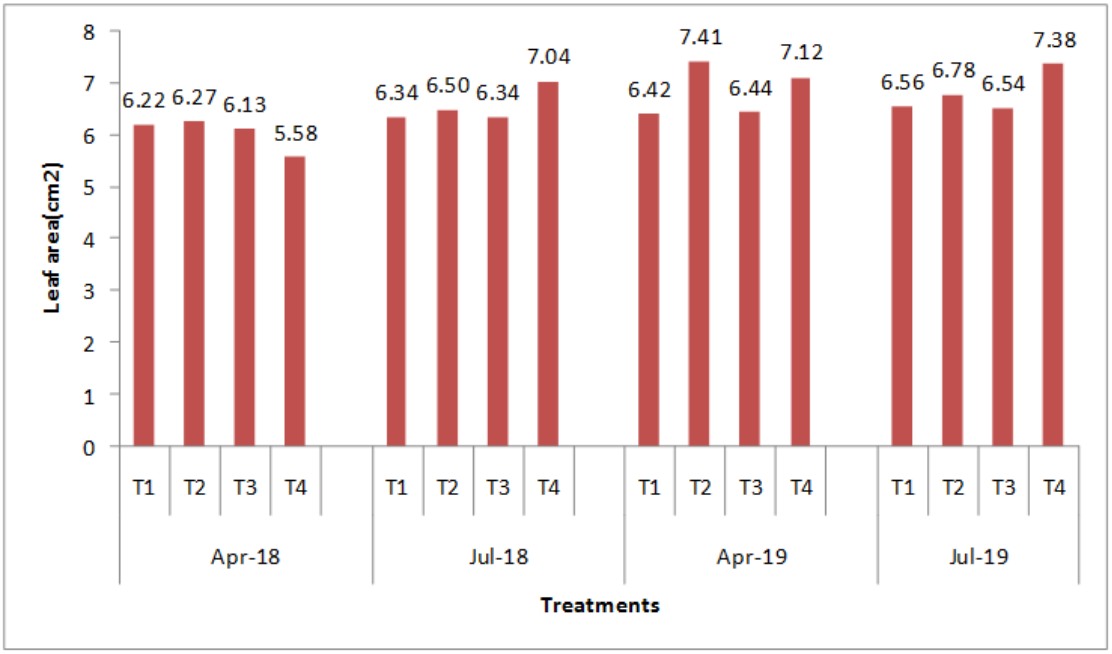
The effect of different treatments on the leaf area of *Melia composita* was statistically non - significant as presented in figure - 4.2. In the month of April the maximum (6.27 cm^2) leaf area was recorded in treatment T_2 which was followed by treatment T_1 (6.22 cm^2). In treatment T_3 leaf area was (6.13 cm^2) and the minimum (5.58 cm^2) leaf area was recorded in treatment T_4.

During July 2018 leaf area presented in figure - 4.2 reveals that maximum (7.04 cm^2) leaf area was recorded in treatment T_4 which was followed by treatment T_2 (6.50 cm^2). Treatment T_3 and T_4 recorded the minimum leaf area of (6.34 cm^2).

In the month of April 2019 the data pertaining to the leaf area was recorded and presented in figure - 4.2. The maximum leaf area of (7.41 cm^2) was observed in treatment T_2 followed by treatment T_4 (7.12 cm^2). In treatment T_3 leaf area of (6.44 cm^2) was recorded and the minimum (6.42 cm^2) leaf area was recorded in treatment T_1.

The observation for the month of July 2018 shows that the leaf area was highest for treatment T_4 (7.38 cm^2) followed by treatment T_2 (6.78 cm^2). In treatment T_1 leaf area of (6.78 cm^2) was recorded and the minimum leaf area of (6.54 cm^2) was recorded in treatment T_4. Overall, the effect of different treatments on leaf area was found to be statistically non-significant.

Fig. 4.2: Effect of different treatments on leaf area (cm^2) of *Melia composita*



4.1.8 Effect of different treatments on chlorophyll content of *Melia composita* (%)

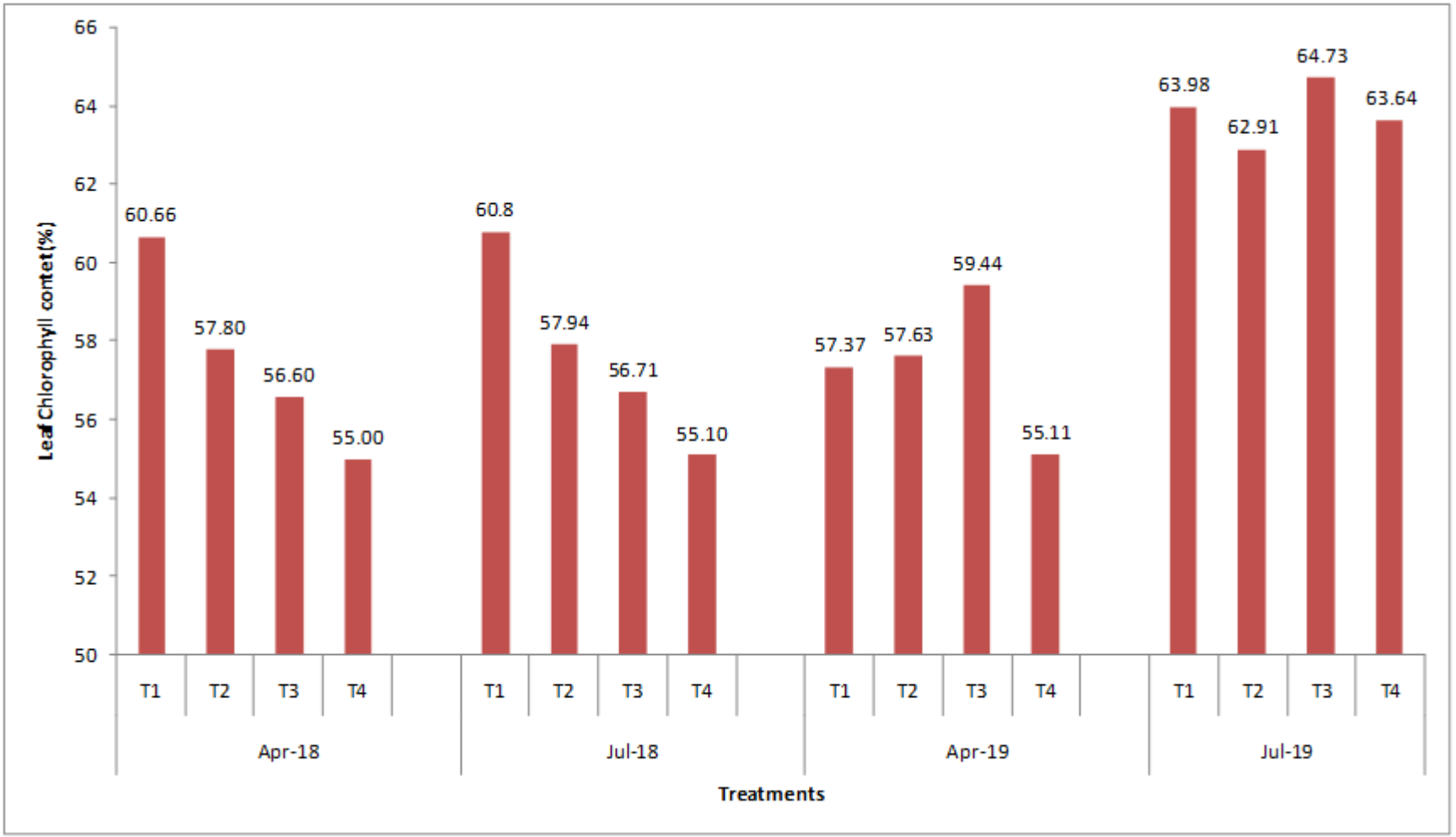
The mean data collected regarding the effect of various treatments of pruning on the chlorophyll content of *Melia composita* have been presented in figure-4.7. It reveals that the chlorophyll content was non significantly affected by various treatments. In the month of April the maximum (60.66 %) chlorophyll content was recorded in treatment T_1 which was followed by treatment T_2 (57.80 %). In treatment T_3 (56.60 %) chlorophyll content was recorded. The minimum chlorophyll content (55.00 %) was recorded in treatment T_4.

Data recorded in July 2018 as presented in figure - 4.7 resulted that maximum (60.80 %) chlorophyll content was recorded in treatment T_1 which was followed by treatment T_2 (57.94 %). In treatment T_3 chlorophyll content of (56.71 %) was recorded and the minimum (55.10 %) was recorded in treatment T_4.

During April 2019 chlorophyll content presented in figure-4.7 reveals that maximum (59.44 %) chlorophyll content was recorded in treatment T_3 followed by treatment T_2 (57.63 %). In treatment T_1 chlorophyll content was 57.37 % and the minimum (55.11 %) chlorophyll content was recorded in treatment T_4.

In the month of July 2019 recorded data presented in figure-4.7 showed that the chlorophyll content was maximum (64.73 %) in treatment T_3 followed by treatment T_1 (63.98 %). In treatment T_4 chlorophyll content was 63.64 % and the minimum chlorophyll content was (62.91 %) in the treatment T_4.

Fig.4.3: Effect of different treatments on chlorophyll content of *Melia composita* (%)



Chapter-5

Discussion

CHAPTER-5

DISCUSSION

The findings of the present investigations entitled **"EFFECT OF PRUNING ON GROWTH CHARACTERISTICS OF *Melia composita*"** was carried out during 2018-2019.This chapter has been devoted to examine the results of the current study based on logical arguments in the light of the scientific evidences available in the literature. Efforts were made during the present investigations to explore the effect of pruning on growth characteristics of *Melia composita*. In addition to this, the aim of the present study was to understand the effect of pruning on light interception in *Melia composita*. This information was essential to know whether initial pruning in *Melia composita* affects the growth characteristics.

The growth parameters like height, crown spread, Light transmission ratio and aboveground biomass were significantly influenced by the different treatments. Diameter at breast height was marginally higher in unpruned treatments (T_1 and T_3) as compared to the treatments in which early pruning was done (T_2 and T_4). However, statistically, all the treatments were at par with each other. So, it can be concluded that initial pruning did not affect the dbh of *Melia composita*. However tree height was more in unpruned trees as compared to pruned trees. Kumar and Rattanpal (2010) reported that it may be due to the fact that pruned trees are unable to make up for the loss of growth caused by severe pruning in this short period. Crown spread was significantly affected as a result of initial pruning. The data reveals that crown spread in unpruned trees was more as compared to pruned trees throughout the study. Moreover, the topping off was done in treatment T_3 and T_4 which drastically reduced the crown spread. A reduction in crown spread also influenced the diameter growth in *Melia composita*. Similar relationships have also been reported by Shepherd (1986) and Pinkard (2002).

It is widely assumed that high intensity and frequent pruning trends to reduce the growth and biomass accumulation (West, 2006). In the present study, the above ground biomass was higher in unpruned treatments compared to the pruned treatments. One possible reason for this could be the initial pruning. Initial pruning resulted in removal of branches that might have resulted in decreased biomass accumulation in the pruned trees. The current finding draws support from the

findings of Devens (2017). Results reveal that there was no difference in above ground biomass. However, higher above ground biomass was recorded since large portion of tree was removed (topped off). However, it is not possible to conclude at this early growth stage of the stand. Other factors such as density and management also influence tree growth.

Our results on light transmission ratio in the current study reveal that early pruning resulted in significant differences in the light transmission ratio (LTR). It may be due to difference in the canopy thickness and difference in the crown spread. Also, pruning involves removal of branches that results in increased penetration of light through the canopy. Similar results have also been reported by Sehgal (2007), Sharma and Singh (2006) and Takiya *et al*. (2010).

Chapter-6

Summary and Conclusion

CHAPTER-6

SUMMARY AND CONCLUSION

The present study **"EFFECT OF PRUNING ON GROWTH CHARACTERISTICS OF *Melia composita*"** was conducted at experimental farm at the Division of Agroforestry, Sher – e – Kashmir University of Agricultural Sciences and Technology of Jammu during 2018 – 2019. The experiment was aimed at exploring the effect of pruning on growth characteristics of *Melia composita* and also to ascertain the light interception in *Melia composita*. The experiment was laid out in Randomized Block Design (RBD) with 5 replications. The results so obtained were subjected to analysis of variance and tested for significant differences. The salient findings and conclusions drawn from the experiment are summarized below with the following headings:

6.1 Effect of pruning on growth characteristics of *Melia composita.*

6.2 Light interception in *Melia composita.*

6.1 Effect of pruning on growth characteristics of *Melia composita.*

The growth parameters of *Melia composita* like tree height, crown spread, number of branches and above ground biomass were significantly influenced by different treatments. Maximum (11.80 m) average tree height was recorded in treatment T_1 where no pruning was done as compared to remaining treatments carried out in *Melia composita* whereas, minimum (4.28 m) average tree height was recorded in T_4. Crown spread was maximum (7.12m) in treatment T_1 whereas, minimum (2.46 m) crown spread was recorded in treatment T_4. The branches per tree were maximum (36.20) in T_1 followed by treatment T_2 (27.44) whereas, the treatment T_3 and T_4 were statistically at par. Above ground biomass was maximum (111.64 kg) in treatment T_1 whereas, it was minimum (35.33 kg) in treatment T_4.

The growth parameters like diameter at breast height, chlorophyll content and leaf area were not significantly influenced by various treatments as the data recorded for all the above parameters were statistically non-significant.

6.2 Light interception in *Melia composita*

Light transmission ratio (LTR) was found to be maximum (76.73%) in treatment T_3 followed by treatment T_4 (55.36%) whereas, minimum (26.82%) light transmission ratio was recorded in treatment T_1.

CONCLUSION

From the present study, it can be concluded that by applying different treatments in *Melia composita*, unpruned trees were found to be better in terms of growth characteristics viz., height, and diameter at breast height, above ground biomass and number of branches. Also light transmission ratio was significantly influenced by early pruning. The effect of various treatments on physiological parameters like chlorophyll content, leaf area was found to be non-significant in the present experiment. The findings of the present investigations indicate that pruned trees showed a minor decline in few of the growth characteristics. However, this reduction is temporary or permanent, need to be explored further. Thus, the current findings provide a scope for new management options in *Melia composita*.

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CERTIFICATE – IV

Certified that all the necessary corrections as suggested by the external examiner and the Advisory committee have been duly incorporated in the thesis entitled "**EFFECT OF PRUNING ON GROWTH CHARACTERISTICS OF *Melia composita***" submitted by **Ms. Qurat Ul Ain Binte Syed**, Registration Number **J-17-M-495.**

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